# AIR QUALITY

## ATIKOKAN
## KENORA
## RED ROCK

Annual Report, 1978



Ministry
of the
Environment
Ontario

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TECHNICAL SUPPORT SECTION
NORTHWESTERN REGION
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# CONTENTS

# SUMMARY

## ATIKOKAN

Air quality studies at Atikokan, undertaken since 1964 by the Ministry in cooperation with two local iron ore mining companies, continued in 1978 with a small vegetation sampling survey, and measurements of dustfall, suspended particulate, and sulphation rates.

In trembling aspen foliage near Caland Ore Limited, fluoride concentrations were slightly elevated but well below levels required for injury to vegetation. Iron concentrations in the same samples, while very high, were similar to values reported in earlier investigations and did not appear to be causing vegetation damage.

Dustfall exceeded the annual air quality objective at sites near Caland Ore, with average values showing no major change from 1977. Dustfall and suspended particulate concentrations in the town of Atikokan were well within Ontario regulations. The continuation of consistently low sulphation rates indicated that average sulphur dioxide concentrations were acceptable. Because of the closure of the mines, all air quality monitoring was discontinued in early 1979, except for suspended particulate measurements in Atikokan.

## KENORA

The Ministry's air quality assessment programme at Kenora began in 1970. Investigations in 1978 included vegetation injury assessment and the operation of a small network of dustfall and sulphation rate monitors in the vicinity of a local sulphite pulp mill.

There was no visible evidence of sulphur dioxide damage to vegetation in 1978. This was the third consecutive year that the area around the mill was free of air pollution injury to plant life.

Dustfall sometimes exceeded provincial regulations, particularly just northeast of the mill. Lignite ash and bark char were the principal components of high dustfall levels. An abatement programme is now under way to reduce this localized nuisance problem.

## RED ROCK

Permanent air quality monitoring sites in Red Rock were first established in April, 1978. The limited data collected for the remainder of that year showed that dustfall levels sometimes exceeded Ontario regulations, and that sodium and sulphate were important components of total dustfall.

The occurrence of extremely high sulphation rates at some monitoring locations indicated that odour concentrations might have reached levels of sufficient magnitude to cause temporary discomfort to local residents.

The Ministry and mill management are currently negotiating an abatement programme to significantly reduce emissions of offensive odours and particulate matter.

## MONITORING METHODS

Dustfall and sulphation rate measurements were carried out in all three communities considered in this report. In addition, a high-volume sampler was operated to monitor suspended particulate levels in Atikokan.

Dustfall comprises particulate matter that settles out from the atmosphere by gravity. It was measured by exposing open-top plastic jars to the air for 30-day periods and then weighing the collected matter. The soluble fraction of dustfall was analysed for iron and sulphate at Atikokan, and for calcium, chloride, sodium and sulphate at Kenora and Red Rock. Determinations of total dustfall and analyses of soluble components were performed at the Ministry's Thunder Bay laboratory.

Suspended particulate constitutes particulate matter of small size which remains in the atmosphere for extended periods. Every sixth day at Atikokan, a measured volume of air was drawn through a fibreglass filter which was weighed at the Ministry's Thunder Bay laboratory before and after the 24-hour sampling period. The difference in filter weight represented the total suspended particulate matter collected.

Sulphation rates provide a semi-quantitative estimate of average monthly levels of sulphur-containing gases in the atmosphere. The method, described in earlier reports (3, 6), is based on the chemical conversion of lead dioxide to lead sulphate. It is non-specific and readings are obtained in the presence of several reactive compounds. The results may also be strongly influenced by variations in temperature, wind speed and humidity. Despite these limitations, the method is useful in determining the presence and extent of elevated sulphur concentrations, and in determining long-term trends.

# ATIKOKAN

## INTRODUCTION

Since 1964, Steep Rock Iron Mines Limited, Caland Ore Limited, and the Ontario Ministry of the Environment have participated in a long-term joint environmental monitoring programme in the vicinity of two iron ore mines and pelletizing plants near Atikokan. These studies (1, 2, 3) showed that iron ore dust was the principal airborne contaminant associated with mining and milling activities. No significant adverse effects, other than aesthetic, could be documented in the area where ore dust levels were elevated. Because the situation appeared stable, air quality monitoring activities were reduced in 1976 and 1977. In 1978, a few vegetation samples were collected, and measurements of dustfall, suspended particulate and sulphation rates were obtained.

## VEGETATION SAMPLING

Fluoride was found to be a minor contaminant in trembling aspen foliage collected in 1975 near Caland Ore's pelletizing plant (2). To determine the severity and extent of elevated fluoride in local vegetation, samples of trembling aspen leaves were obtained in August, 1978, from nine sites near Caland's plant (Figure 1). Triplicate samples from each site were processed at the Ministry's Thunder Bay laboratory and submitted to the Toronto laboratory for fluoride analysis by the alizarin fluorine blue method. Iron analysis of the same samples, by atomic absorption spectrophotometry, was carried out in Thunder Bay.

All sample material, except that from sites 1, 9, and the controls, bore a heavy visible deposit of iron ore dust. This finding is reflected in the high iron concentrations reported in Table 1. Fluoride levels, while slightly elevated, were well below the Ministry guideline and much lower than concentrations normally associated with injury to sensitive plant species. Both

fluoride and iron values were similar to those reported earlier (1, 2). Ministry studies have now shown that dust emissions from Caland Ore are a significant source of iron contamination, a moderate source of arsenic, and a very slight source of fluoride. None of these pollutants, however, have been shown to adversely effect local vegetation.

## AIR QUALITY MONITORING

### Dustfall

Total dustfall (Table 2) sometimes exceeded the monthly air quality objective, particularly at stations 62061 and 62062, (Figure 2) northeast of Caland Ore. Results at station 62062 may have been influenced by construction activity at the nearby site of the Ontario Hydro thermal generating station. Because of this probable interference, dustfall monitoring at this location was discontinued in October, 1978.

Dustfall was above the annual objective at four sites (Figure 3), with overall results about the same for both 1977 and 1978. Iron, expressed as iron oxide, accounted for about 10 to 35 percent of total dustfall. The highest percentages of iron were associated with the highest dustfall values. Sulphate was consistently low at all sites.

### Suspended Particulate

As in 1977, the 24-hour Ontario objective was exceeded only once in 57 samples (Table 3). The annual mean of 28 $\mu g/m^3$ (micrograms of particulate matter per cubic metre of air) was slightly below the 30 $\mu g/m^3$ recorded in both 1976 and 1977 and well below the maximum acceptable limit of 60 $\mu g/m^3$ prescribed in provincial regulations. Since average values were the same for both northerly and southerly prevailing wind, there was no evidence that emissions from iron mining and milling operations contributed significantly to suspended particulate concentrations in the town of Atikokan.

### Sulphation Rates

Sulphation rates were very low throughout the study area (Table 4) and were similar to those encountered in earlier years. The data indicate that average levels of sulphur-containing pollutants were acceptable. Because of the termination of operations at Steep Rock in the summer of 1979 and at Caland Ore in 1981, dustfall and sulphation rate monitoring around the two mines were discontinued in March, 1979. Suspended particulate measurements in the town of Atikokan will continue and become part of the environmental monitoring programme for the thermal generating station to be built at Marmion Lake.

# KENORA

## INTRODUCTION

In Kenora, the Ministry's air quality investigations, which began in 1970, have been designed to assess effects of emissions from a local sulphite pulp mill. Previous reports (4, 5, 6) indicated that the mill was a source of sulphur dioxide emissions which periodically caused vegetation damage, but that this problem had not appeared since 1975. Emissions of particulate matter from the mill's power boiler stack were occasionally found to be a nuisance to nearby residents. The Ministry's 1978 assessment programme at Kenora included routine inspections of vegetation, and the operation of a small network of dustfall and sulphation rate monitors.

## VEGETATION ASSESSMENT

A general inspection of vegetation around the sulphite pulp mill was carried out on June 6, July 11 and August 2. The absence of visible sulphur dioxide injury to vegetation on all these

dates marks the third consecutive year that such damage has been absent. Moderate to severe injury from forest tent caterpillar (*Malacosoma disstria*) was noted on June 6, mainly on local trembling aspen on mill property. Most trees showed signs of good recovery by producing new foliage in July and August.

## AIR QUALITY MONITORING

### Dustfall

Total dustfall in Kenora, at locations shown in Figure 4, is summarized in Table 5. The monthly objective was exceeded at least once at all sites, and the annual objective was not met at any of the stations. As in 1977, the most frequent violations occurred at station 61007, northeast of the mill. Excessive dustfall here was attributed mainly to lignite ash and bark char, which were often visible in jars exposed at this site. The extremely high dustfall in February at station 61003 also consisted mainly of lignite ash, with a minor amount of bark char. Average dustfall levels decreased rapidly as distance from the mill increased (Figure 5). Dustfall declined dramatically in December, when no lignite was burned at the mill. The comparisons in Table 6 show that dustfall in 1978 did not improve from the situation 5 years earlier. Soluble chloride, sodium and sulphate in dustfall were all at or near normal background levels at all sites. Calcium was slightly elevated at station 61007.

The fallout of bark char and lignite ash around the mill has led to periodic complaints from local residents. Although neither contaminant is hazardous to human health or toxic to vegetation, they can create a nuisance if present in excess amounts. Bark char discharges may continue to pose an occasional minor problem under upset conditions in the operation of the mill's fluidized bed bark burner. Some recent improvements have been made in the two lignite coal boilers and, under the provisions of an existing control order, particulate emissions from these sources are to comply with Ontario regulations by 1982.

### Sulphation Rates

Kenora's sulphation rates for 1978 (Table 7) were about the same as those in 1977. Annual averages were also very similar at the four sites (Figure 6). The results for some months show that sulphur levels were occasionally significantly elevated (for example in July at station 61007 and in August at 61008). To determine whether sulphur dioxide concentrations exceed Ontario regulations in such situations, a continuous analyser would have to be operated in the vicinity of the mill.

# RED ROCK

## INTRODUCTION

Snow sampling and moss exposure experiments in Red Rock during 1976, 1977 and 1978 revealed that the local kraft pulp mill was a source of particulate emissions containing calcium, chloride, sodium and sulphate (7, 8, 9). Mobile monitoring equipment, in late 1977, also encountered very high levels of total reduced sulphur (TRS) downwind of the mill (10), although concentrations of sulphur dioxide and nitrogen oxides were acceptable. Air quality monitoring at fixed locations did not begin until April, 1978, when four sites were established to measure dustfall and sulphation rates.

## AIR QUALITY MONITORING

### Dustfall

Measurements of total dustfall, and soluble calcium, chloride, sodium, and sulphate in dustfall are summarized in Table 8 and Figure 8 for April to December, 1978. Monitoring locations are shown in Figure 7. The monthly air quality objective for total dustfall was exceeded occasionally at station 63080, frequently at 63082, and not at all at the other two sites. Sodium and

sulphate accounted for a higher proportion of total dustfall at the two sites with highest dustfall readings than at the two sites with lowest dustfall. Calcium was slightly elevated and chloride was very low throughout the study area. Trace to moderate amounts of black particulate matter (probably bark char) were noted from time to time in the dustfall jars, particularly those at sites 63080 and 63082. Wood fines were also occasionally observed in jars exposed at 63080. In October, a white powdery substance was found on the outside of all jars on the side facing the mill.

Results to date indicate that the mill is responsible for particulate fallout in Red Rock at levels which sometimes exceed Ministry regulations. The components of the dustfall may be responsible for occasional nuisance effects but, at the levels recorded, are not considered harmful to human health or toxic to plant life. The Ministry is currently negotiating a control programme with the company which should result in significantly reduced particulate emissions.

Sulphation Rates

Sulphation rates recorded for Red Rock in 1978 are given in Table 9 and the averages plotted in Figure 9. There were some extremely high values recorded at station 63080, with intermittent elevated readings at 63081 and 63082. The monitoring site at 122 Brompton Road gave the only consistently low sulphation rates. Although sulphation measurements provide only a crude estimate of average gaseous sulphur concentrations, it is estimated that a reading above 0.20 mg $SO_3$/100 $cm^2$/day (milligrams of $SO_3$ per 100 square centimetres of treated paper per day) in the vicinity of a kraft pulp mill indicates unacceptably high odour levels. Some of the values for 63080 could therefore mean that offensive odours from the mill would be many times greater than the maximum permitted by the Ontario guideline. As noted earlier in this report, a short-term study in 1977 documented the presence of excessive odour levels in Red Rock (10). At the maximum concentrations found in 1977, some individuals might experience

symptoms of discomfort, such as respiratory irritation, nausea, and sleep loss. All such effects, however, would be temporary and would disappear when odour levels decreased as a result of reduced emissions from the source or a change in wind direction. The Ministry is currently negotiating an abatement programme with mill management which, if implemented, will significantly reduce odour problems in Red Rock.

ACKNOWLEDGEMENTS

The Ministry wishes to thank Steep Rock Iron Mines Limited and Caland Ore Limited for their long-standing cooperation in operating the Atikokan dustfall and sulphation monitoring network. The assistance of staff at the Atikokan Wheather Station for operating the high-volume sampler is also gratefully acknowledged.

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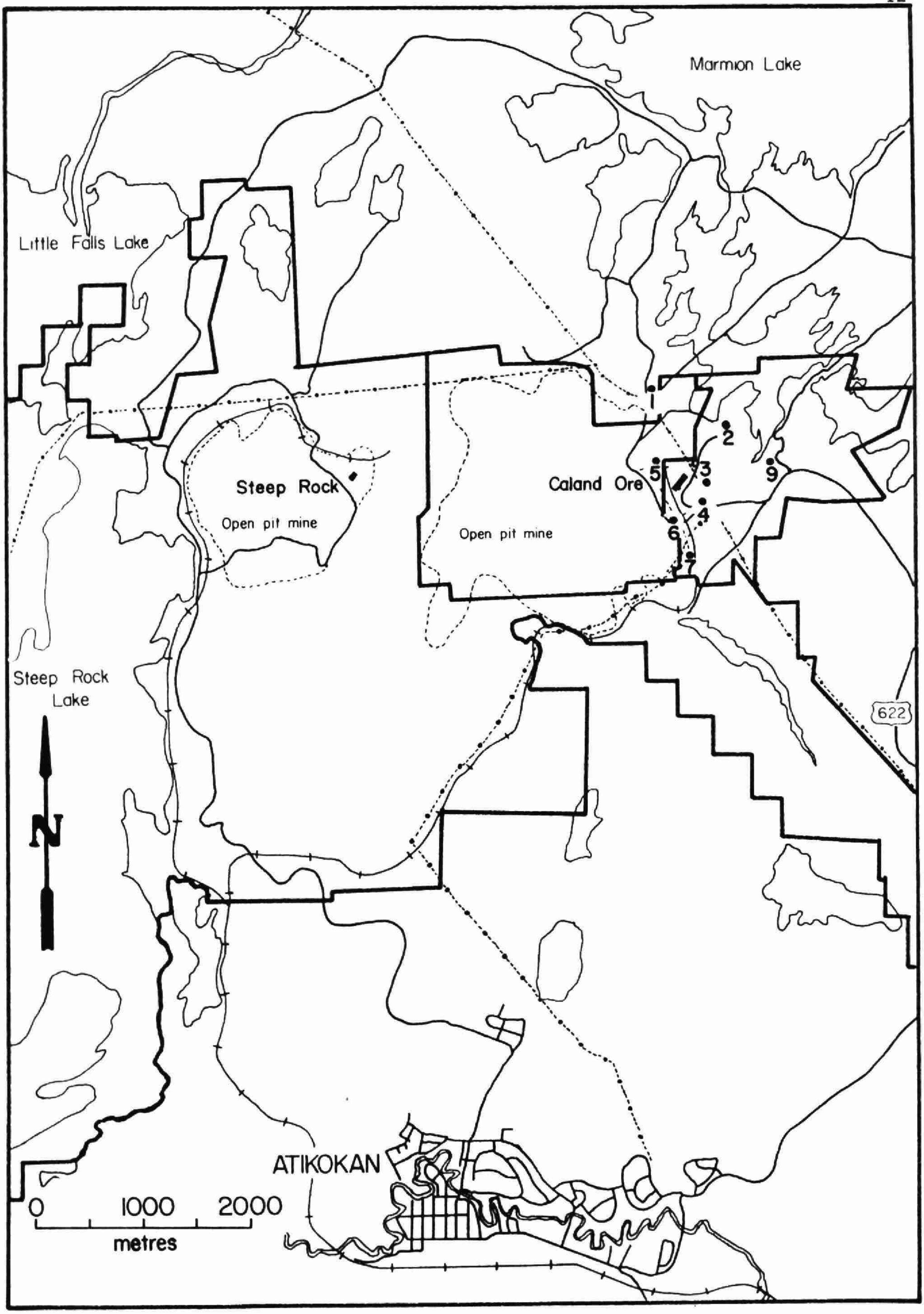


Figure 1. Trembling aspen sampling sites, Atikokan, 1978.

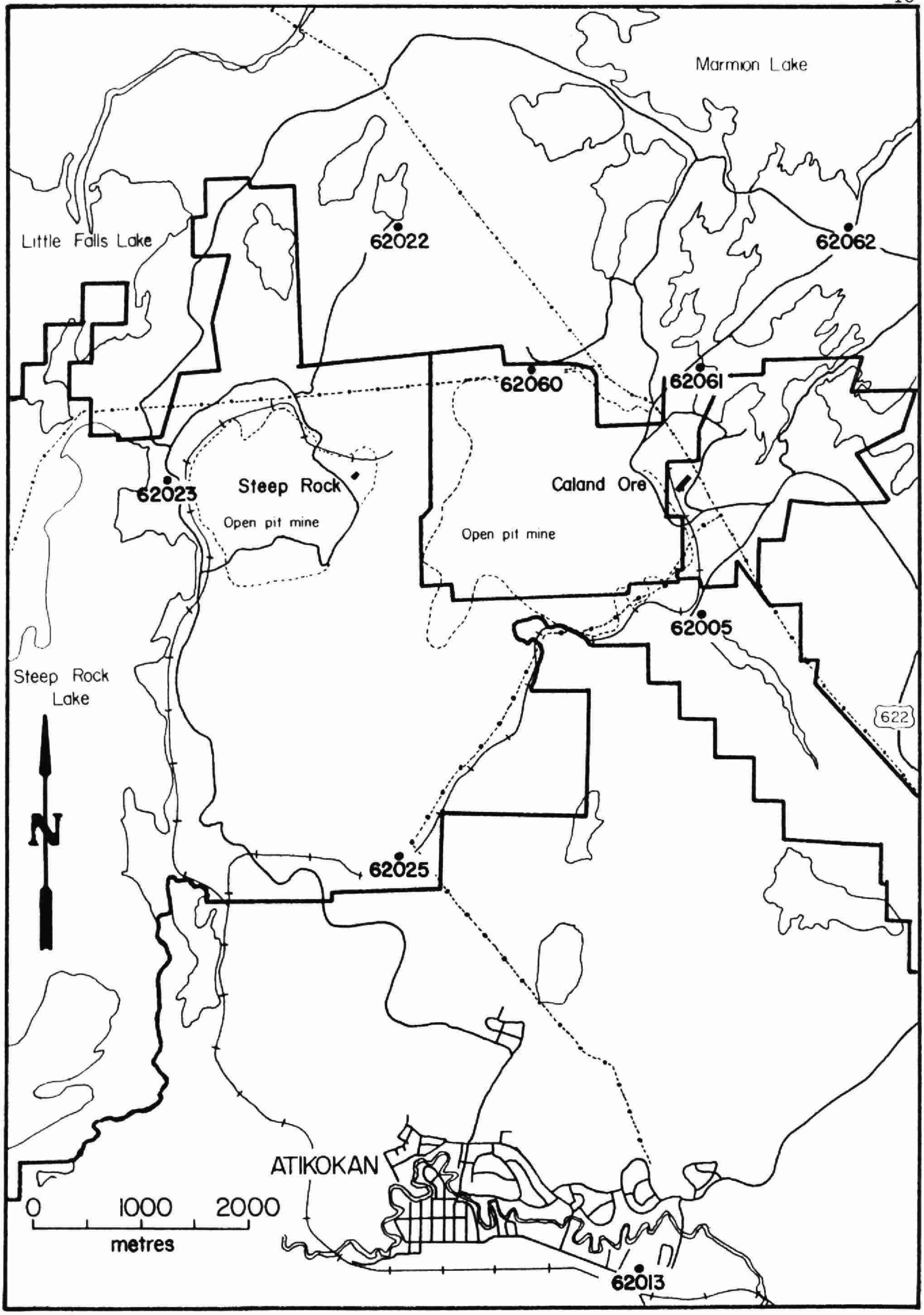


Figure 2. Air quality monitoring sites, Atikokan, 1978 (except station 62063).

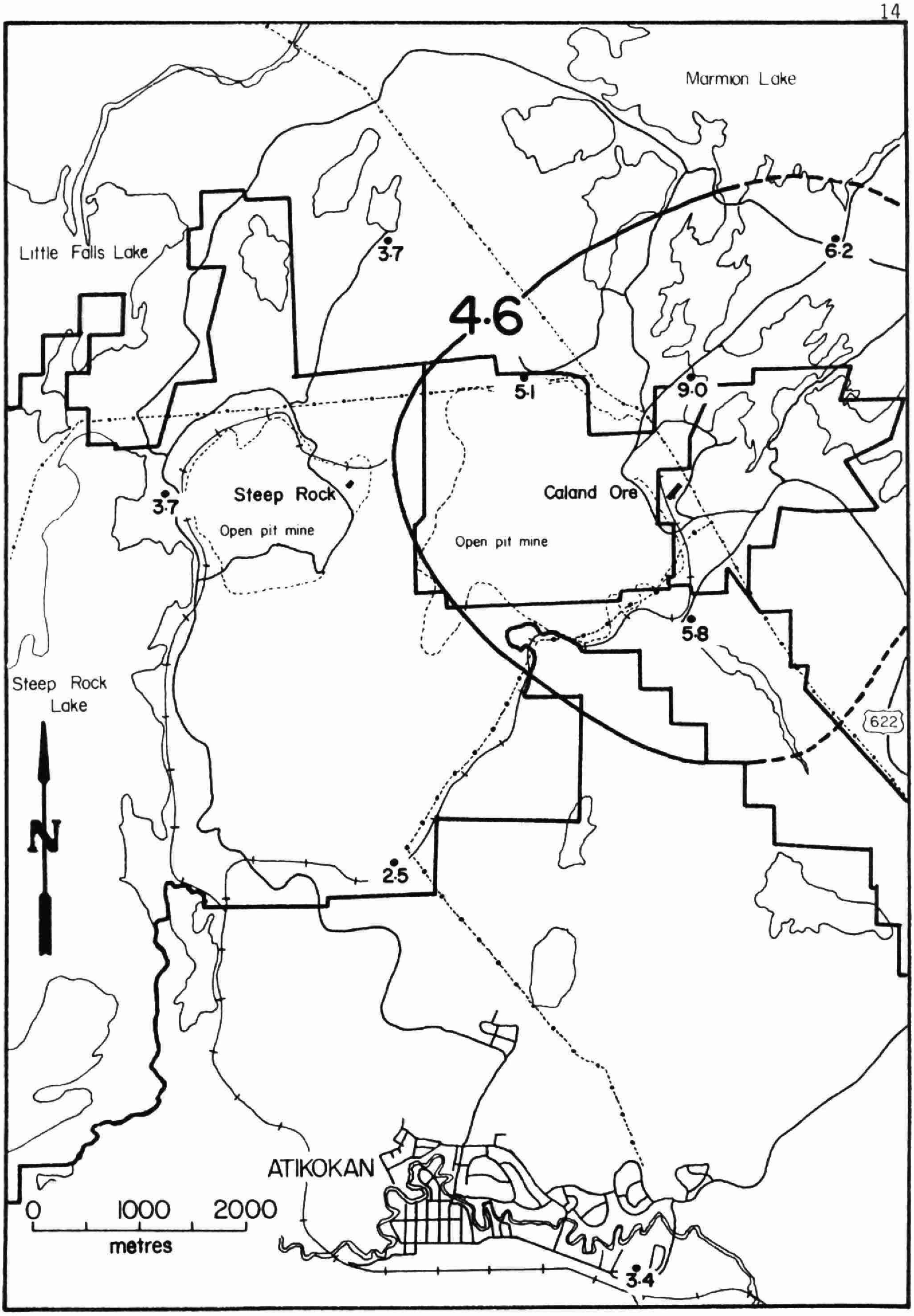


Figure 3. Average dustfall, Atikokan, 1978 ( g/m²/ 30 days ).

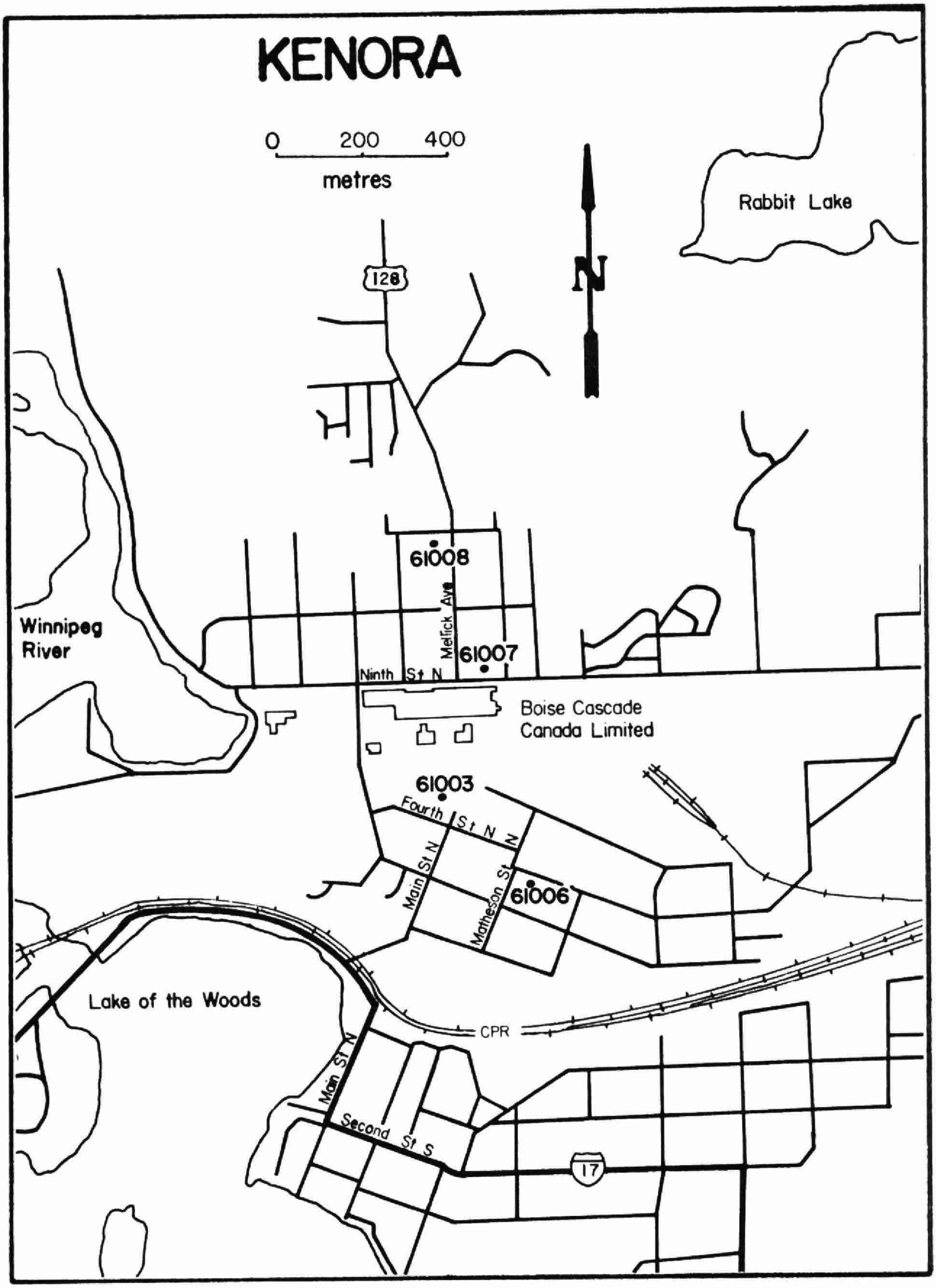


Figure 4. Air quality monitoring sites, Kenora, 1978.

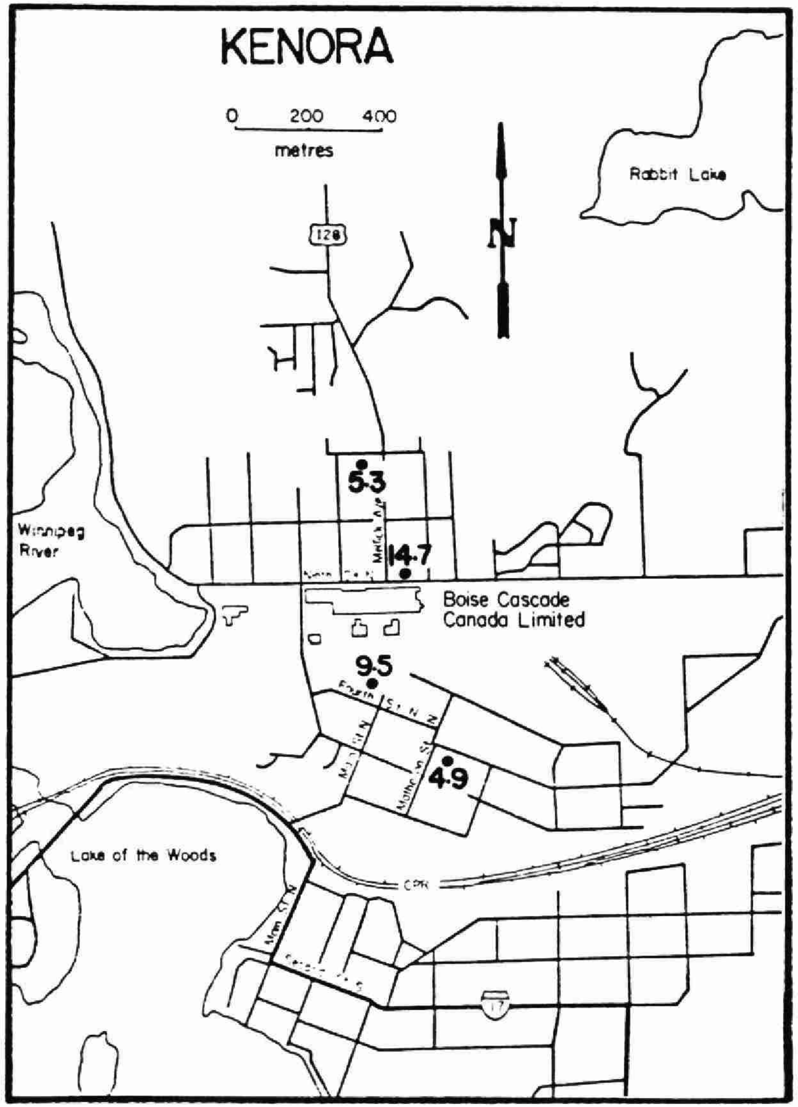


Figure 5. Average dustfall, Kenora, 1978.
( $g/m^2/30$ days)

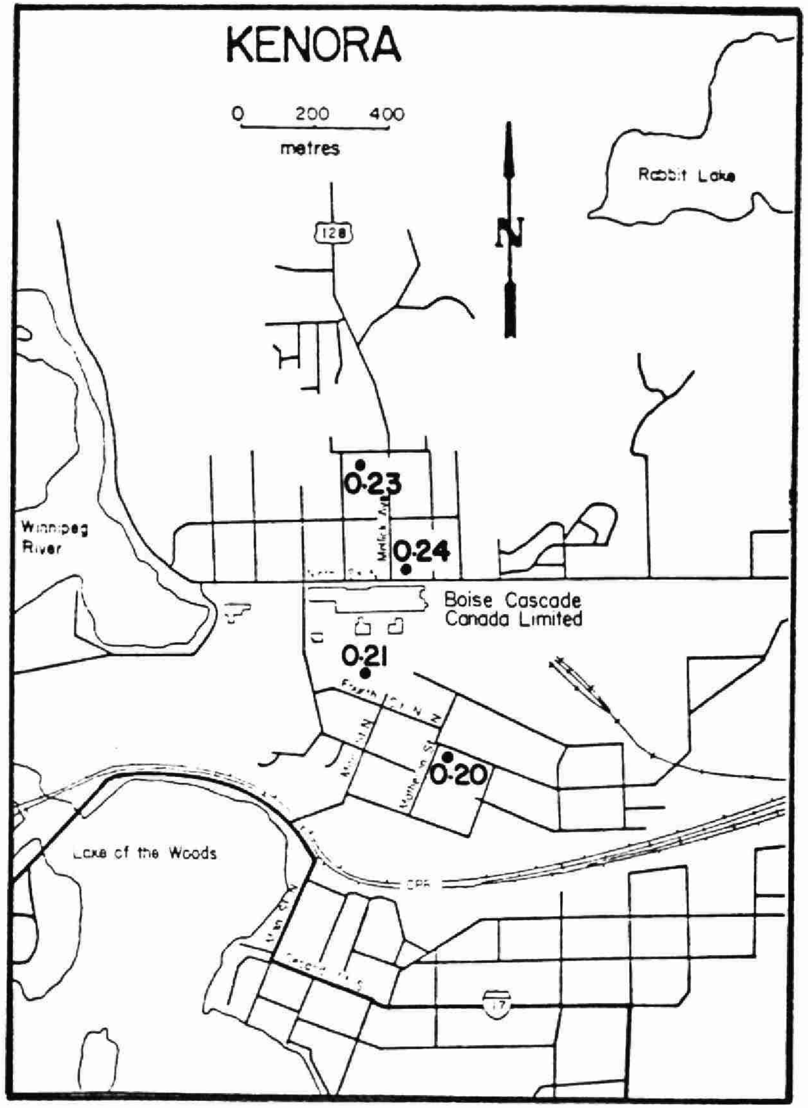


Figure 6. Average sulphation rate, Kenora, 1978.
( mg $SO_3$/100 $cm^2$/day)

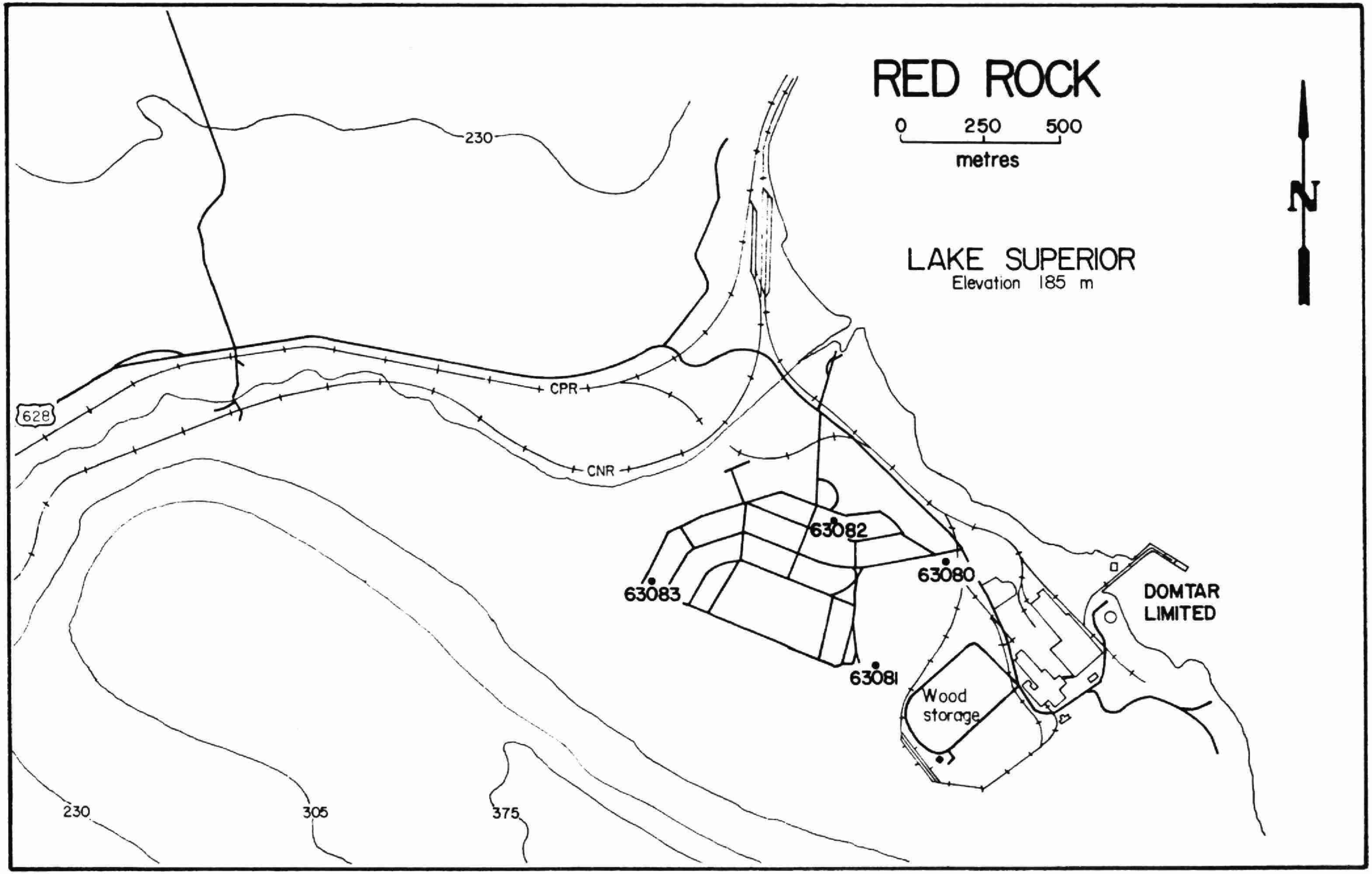


Figure 7. Air quality monitoring sites, Red Rock, 1978.

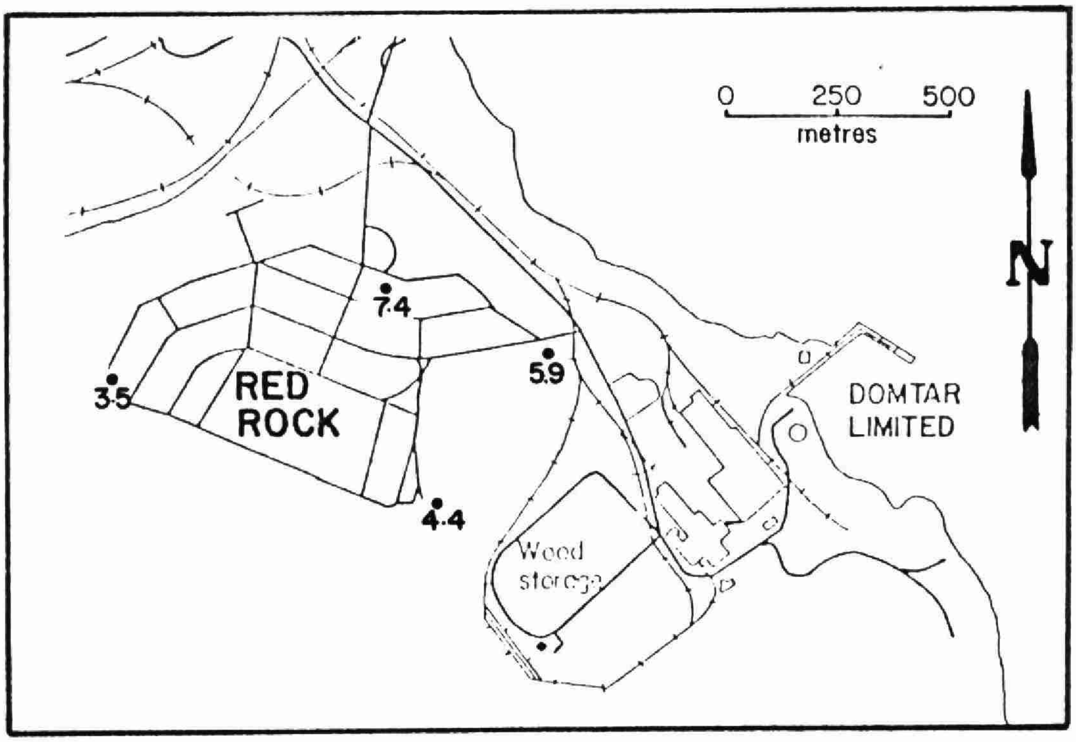


Figure 8. Average dustfall, Red Rock, 1978 ( $g/m^2/30$ days).

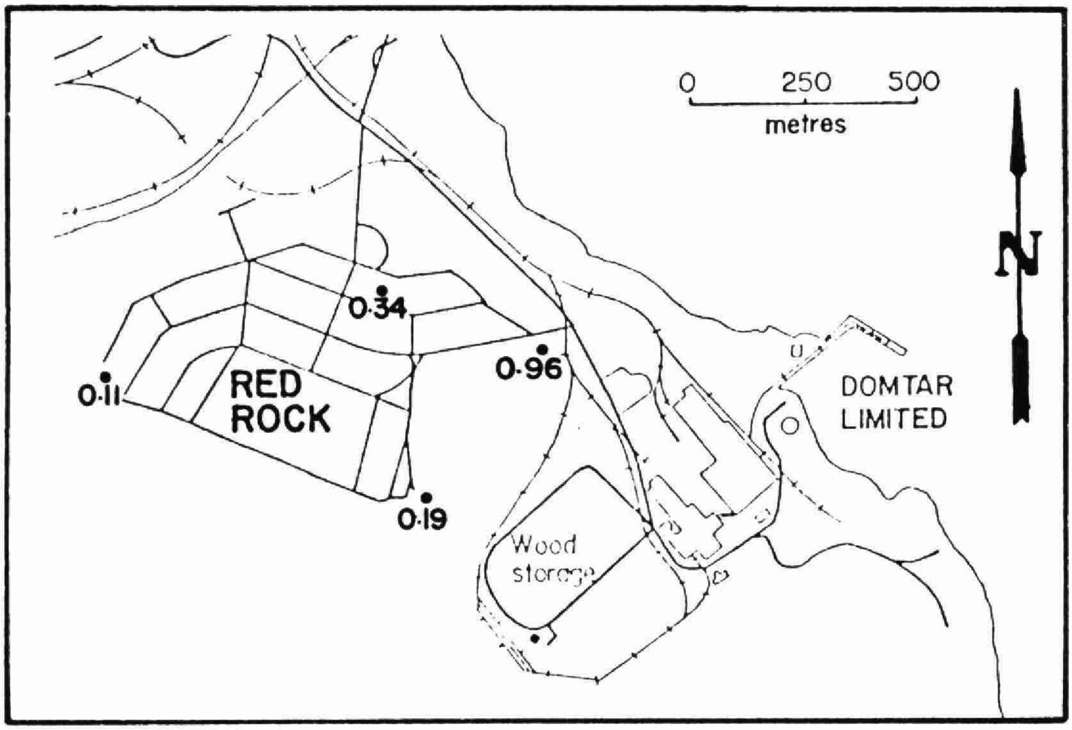


Figure 9. Average sulphation rate, Red Rock, 1978 (mg $SO_3$/ 100 $cm^2$/ day).

TABLE 1. Average fluoride and iron concentrations ($\mu g/g$, dry weight) in unwashed trembling aspen foliage, Atikokan, August, 1978.

| Sampling site | Fluoride | Iron |
|---|---|---|
| 1 | 4 | 1200 |
| 2 | 7 | 14000 |
| 3 | 9 | 18000 |
| 4 | 14 | 35000 |
| 5 | 6 | 10000 |
| 6 | 9 | 14000 |
| 7 | 16 | 18000 |
| 8 | 11 | 11000 |
| 9 | 5 | 3300 |
| Controls | 2 | 210 |
| Guidelines | 35 | 800 |

TABLE 2. Total dustfall and iron in dustfall ($g/m^2$/30 days), Atikokan, 1978.

| Station | Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total dustfall | | | | | | | | | | | | |
| 62005 | Fairweather | 4.9 | 8.4[a] | 5.6 | 3.8 | 9.4 | 6.9 | 6.8 | 6.0 | - | 3.9 | 4.5 | 3.6 | 5.8 |
| 62013 | Atikokan | 0.4 | 2.1 | 3.2 | 3.6 | 7.7 | 4.6 | 3.7 | 3.4 | 2.6 | 4.8 | 3.0 | 1.2 | 3.4 |
| 62022 | Mary Lake | 1.0 | 1.4 | 3.5 | 4.4 | 5.8 | 4.0 | 7.2 | 5.1 | 2.9 | 4.0 | 3.4 | 1.3 | 3.7 |
| 62023 | Water Tower | 1.7 | 2.6 | 1.6 | 3.4 | 5.4 | 3.6 | 8.9 | - | 3.2 | 6.5 | 2.3 | 1.2 | 3.7 |
| 62025 | Pal Lake Road | 2.5 | 1.7 | 1.1 | 1.9 | 7.0 | 2.1 | 4.2 | 3.1 | 1.0 | 1.5 | 3.2 | 1.3 | 2.5 |
| 62060 | Lime Point | 3.4 | 3.5 | 5.6 | 6.8 | - | 6.7 | 5.2 | 4.9 | 6.0 | 6.2 | 5.2 | 2.2 | 5.1 |
| 62061 | Moose Lake Dam | 2.2 | 3.5 | 4.2 | 5.2 | 24.0 | 11.2 | 23.0 | 11.8 | 4.7 | 5.5 | 10.8 | 2.5 | 9.0 |
| 62062 | Mando Road Dump | 2.2 | 1.8 | 7.7 | - | 8.9 | 8.7 | 7.6 | 5.9 | 3.8 | 9.1 | | | 6.2 |
| | | Iron in total dustfall | | | | | | | | | | | | |
| 62005 | Fairweather | 0.4 | | | 0.2 | 1.0 | 0.7 | 0.5 | 0.8 | 0.1 | 0.8 | 0.3 | 0.3 | 0.5 |
| 62013 | Atikokan | 0.1 | | | - | 0.3 | 0.2 | <0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 |
| 62022 | Mary Lake | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | <0.1 | 0.3 | 0.3 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 |
| 62023 | Water Tower | 0.3 | 0.2 | 0.1 | 0.2 | 0.2 | <0.1 | 0.2 | 1.2 | - | 0.2 | 0.2 | 0.1 | 0.3 |
| 62025 | Pal Lake Road | 0.1 | 0.1 | 0.1 | 0.3 | 0.3 | <0.1 | - | <0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 |
| 62060 | Lime Point | 0.3 | | | 0.3 | - | 0.6 | <0.1 | 0.7 | 0.5 | 0.4 | 0.5 | 0.3 | 0.4 |
| 62061 | Moose Lake Dam | 0.2 | | | 0.4 | 1.6 | 0.9 | 3.8 | 1.7 | 0.9 | 0.9 | 1.0 | 0.3 | 1.2 |
| 62062 | Mando Road Dump | 0.2 | | | - | 0.4 | 1.0 | 0.2 | 0.4 | 0.3 | 0.6 | | | 0.4 |

[a]Values exceeding maximum acceptable level of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 3. Total suspended particulate matter ($\mu g/m^3$), station 62013, Atikokan, 1978.

| Date | $\mu g/m^3$ | Wind[a] | Date | $\mu g/m^3$ | Wind |
|---|---|---|---|---|---|
| Jan 2 | 9 | WNW 12 | Jul 1 | 41 | SE 6 |
| 8 | 20 | NNW 18 | 7 | 46 | N 4 |
| 14 | 31 | ESE 2 | 13 | 35 | SVRL 10 |
| 20 | 44 | WNW 0 | 19 | 29 | NNW 4 |
| 26 | 20 | N 16 | 25 | 48 | SSW 11 |
| | | | 31 | 25 | SVRL 7 |
| Feb 1 | 39 | W 3 | Aug 6 | 28 | SSW 11 |
| 7 | 18 | ENE 3 | 12 | 54 | S 8 |
| 13 | 29 | SVRL[b] 7 | 18 | - | - |
| 19 | 20 | E 4 | 24 | 35 | ESE 2 |
| 25 | 15 | NW 8 | 30 | - | - |
| Mar 3 | 51 | N 8 | Sep 5 | 62 | SVRL 6 |
| 9 | 21 | W 12 | 11 | 21 | ENE 12 |
| 15 | 41 | N 4 | 17 | 39 | S 4 |
| 21 | 16 | S 4 | 23 | 49 | SSW 11 |
| 27 | 32 | WNW 11 | 29 | 12 | NE 7 |
| Apr 2 | 27 | ESE 14 | Oct 5 | 14 | N 10 |
| 8 | - | - | 11 | 50 | S 15 |
| 14 | 26 | NW 16 | 17 | 56 | SSW 11 |
| 20 | 47 | SVRL 9 | 23 | 28 | S 12 |
| 26 | 115 | NNW 4 | 29 | 22 | SSE 14 |
| May 2 | <u>129</u>[c] | WNW 4 | Nov 4 | 48 | ESE 6 |
| 8 | - | - | 10 | 31 | ENE 12 |
| 14 | 39 | SVRL 13 | 16 | 22 | S 4 |
| 20 | 31 | N 11 | 22 | 20 | W 3 |
| 26 | 77 | SE 8 | 28 | 9 | SVRL 5 |
| Jun 1 | 13 | ESE 9 | Dec 4 | 14 | WSW 10 |
| 7 | 39 | NE 7 | 10 | 17 | W 3 |
| 13 | 62 | SVRL 3 | 16 | 8 | W 8 |
| 19 | 50 | S 17 | 22 | 15 | W 11 |
| 25 | 33 | S 4 | 28 | 2 | E 13 |

[a]Prevailing wind direction and average wind speed (kph) recorded 10 m above ground level.

[b]SVRL = Several.

[c]Values exceeding maximum acceptable level of 120 $\mu g/m^3$ (24-hour average) are underlined.

TABLE 4. Sulphation rates (mg $SO_3$/100 $cm^2$/day), Atikokan, 1978.

| Station | Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62005 | Fairweather | .13 | .06 | .06 | .04 | <.01 | .04 | | .12 | <.01 | .05 | .04 | .06 | .06 |
| 62013 | Atikokan | .14 | .04 | .03 | .07 | <.01 | .02 | | .06 | <.01 | <.01 | .07 | .04 | .04 |
| 62022 | Mary Lake | .09 | .09 | .02 | .03 | <.01 | .04 | .04 | .03 | .01 | | .02 | .02 | .04 |
| 62023 | Water Tower | .11 | .08 | .01 | .03 | .02 | <.01 | <.01 | .06 | .02 | | .01 | .01 | .03 |
| 62025 | Pal Lake Road | .03 | .08 | .02 | <.01 | <.01 | .02 | .01 | .03 | <.01 | | .02 | .03 | .02 |
| 62060 | Lime Point | .09 | .01 | .02 | .02 | <.01 | .09 | | .08 | .03 | .06 | .05 | .04 | .04 |
| 62061 | Moose Lake Dam | .09 | .03 | .06 | .02 | <.01 | .09 | | .06 | .07 | .06 | .04 | .05 | .05 |
| 62063 | Nym Lake | .13 | .03 | .03 | .01 | <.01 | <.01 | | .01 | .04 | .03 | | | .03 |

TABLE 5. Dustfall ($g/m^2$/30 days), Kenora, 1978.

| Station | Location | Distance (metres) and direction from source[a] | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61003 | Fourth/Main | 140 S | 5.1 | 51.4[b] | 7.4 | 7.2 | 17.1 | 5.0 | 3.2 | 5.0 | 4.2 | 6.0 | 1.8 | 0.8 | 9.5 |
| 61006 | Matheson/Fourth | 395 SE | 7.4 | 6.2 | 3.5 | 3.1 | 10.8 | - | - | 5.4 | 4.1 | 2.3 | 1.5 | | 4.9 |
| 61007 | Melick/Ninth | 225 NE | 15.7 | 8.2 | 17.6 | 17.1 | 14.1 | 10.9 | 8.1 | 16.0 | 23.8 | 20.4 | 11.5 | 0.7 | 14.7 |
| 61008 | Melick/Eleventh | 475 N | 3.3 | 5.3 | 4.3 | 16.3 | 5.1 | 13.3 | 2.4 | 2.9 | 4.8 | 3.1 | 1.9 | 0.6 | 5.3 |

[a]Source arbitrarily designated as digester relief stack, Boise Cascade Canada Limited sulphite mill.

[b]Values exceeding maximum acceptable levels of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 6. Comparison between average annual dustfall ($g/m^2$/30 days) in Kenora from 1974 to 1978.

| Station | Location | 1974 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|
| 61003 | Fourth/Main | 6.3[a] | 5.6 | 4.2 | 5.7 | 9.5 |
| 61006 | Matheson/Fourth | 5.2 | 4.2 | 3.5 | 4.4 | 4.9 |
| 61007 | Melick/Ninth | 14.4 | 7.7 | 8.4 | 11.9 | 14.7 |
| 61008 | Melick/Eleventh | 6.3 | 6.0 | 3.2 | 3.7 | 5.3 |

[a]Values exceeding maximum acceptable level of 4.6 (annual average) are underlined.

TABLE 7. Sulphation rates (mg $SO_3$/100 $cm^2$/day), Kenora, 1978.

| Station | Location | Distance (metres) and direction from source[a] | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61003 | Fourth/Main | 140 S | .20 | .21 | .11 | .17 | .47 | .24 | .10 | .29 | .05 | .48 | .13 | .10 | .21 |
| 61006 | Matheson/Fourth | 395 SE | .33 | .21 | .48 | .07 | .10 | .15 | .08 | .19 | .15 | .30 | .12 | - | .20 |
| 61007 | Melick/Ninth | 225 NE | .12 | .07 | .17 | .15 | .13 | .33 | .72 | .26 | .20 | .37 | .11 | .12 | .24 |
| 61008 | Melick/Eleventh | 475 N | .12 | .09 | .16 | .09 | .22 | .24 | .23 | .54 | .49 | .41 | .09 | .12 | .23 |

[a]Source arbitrarily designated as digester relief stack, Boise Cascade Canada Limited sulphite mill.

TABLE 8. Dustfall (g/m$^2$/30 days), Red Rock, 1978.

| Station | Location | Distance (metres) and direction from source[a] | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Total dustfall | | | | | | | |
| 63080 | Rankin Street | 550 NW | | | | 5.9 | 6.6 | 7.2[b] | 6.7 | 6.6 | 9.1 | 5.5 | 3.3 | 2.6 | 5.9 |
| 63081 | Stewart/Frost | 550 W | | | | 5.4 | 5.5 | 4.1 | 5.1 | 3.7 | 5.0 | 5.1 | 3.1 | 2.2 | 4.4 |
| 63082 | 47 Timmins Street | 875 NW | | | | 7.7 | 13.4 | 8.2 | 9.8 | 6.6 | 8.2 | 5.4 | 4.3 | 2.6 | 7.4 |
| 63083 | 122 Brompton Road | 1300 WNW | | | | 3.3 | 5.1 | 4.5 | 3.5 | 3.7 | 4.5 | 2.5 | 2.5 | 1.6 | 3.5 |
| | | | | | | | | Soluble sodium in dustfall | | | | | | | |
| 63080 | Rankin Street | 550 NW | | | | 0.6 | 0.4 | 0.9 | 0.8 | 0.8 | 1.1 | 0.7 | 0.3 | 0.3 | 0.6 |
| 63081 | Stewart/Frost | 550 W | | | | 0.4 | 0.6 | 0.2 | 0.4 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 | 0.4 |
| 63082 | 47 Timmins Street | 875 NW | | | | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.4 | 0.8 | 0.7 |
| 63083 | 122 Brompton Road | 1300 WNW | | | | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | | | | | | | | Soluble sulphate in dustfall | | | | | | | |
| 63080 | Rankin Street | 550 NW | | | | 1.6 | 1.3 | 1.9 | 1.5 | 1.8 | 2.6 | 1.4 | 0.5 | 0.6 | 1.5 |
| 63081 | Stewart/Frost | 550 W | | | | 0.6 | 1.1 | 0.5 | 0.9 | 0.8 | 0.9 | 1.2 | 0.5 | 0.3 | 0.8 |
| 63082 | 47 Timmins Street | 875 NW | | | | 1.9 | 1.5 | 1.6 | 1.6 | 1.7 | 1.9 | 1.2 | 0.7 | 0.8 | 1.4 |
| 63083 | 122 Brompton Road | 1300 WNW | | | | 0.5 | 1.0 | 0.5 | 0.5 | 0.5 | 0.7 | 0.4 | 0.4 | 0.3 | 0.5 |

[a] Source arbitrarily designated as recovery furnace stacks, Domtar kraft mill.

[b] Values exceeding maximum acceptable levels of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 8, continued.

| Station | Location | Distance (metres) and direction from source[a] | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Soluble calcium in dustfall | | | | | | | | | | | | |
| 63080 | Rankin Street | 550 NW | | | | 0.4 | 0.6 | 0.5 | 0.4 | 0.6 | 0.3 | 0.2 | 0.2 | 0.1 | 0.4 |
| 63081 | Stewart/Frost | 550 W | | | | 0.2 | 0.5 | 0.2 | 0.2 | 0.8 | 0.2 | 0.3 | 0.2 | <0.1 | 0.3 |
| 63082 | 47 Timmins Street | 875 NW | | | | 0.5 | 0.6 | 0.4 | 0.5 | 0.2 | 0.8 | 0.4 | 0.4 | 0.2 | 0.4 |
| 63083 | 122 Brompton Road | 1300 WNW | | | | 0.2 | 0.4 | 0.3 | 0.2 | 0.2 | 0.3 | 0.1 | 0.2 | <0.1 | 0.2 |
| | | | Soluble chloride in dustfall | | | | | | | | | | | | |
| 63080 | Rankin Street | 550 NW | | | | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 63081 | Stewart/Frost | 550 W | | | | 0.3 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 63082 | 47 Timmins Street | 875 NW | | | | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 63083 | 122 Brompton Road | 1300 WNW | | | | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

[a]Source arbitrarily designated as recovery furnace stacks, Domtar kraft mill.

TABLE 9. Sulphation rates (mg $SO_3$/100 $cm^2$/day), Red Rock, 1978.

| Station | Location | Distance (metres) and direction from source[a] | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63080 | Rankin Street | 550 NW | | | | 1.33 | .39 | 1.05 | .76 | 1.20 | 2.31 | 1.00 | .11 | .54 | .96 |
| 63081 | Stewart/Frost | 875 NW | | | | .16 | .14 | .11 | .18 | .25 | .44 | - | .14 | .07 | .19 |
| 63082 | 47 Timmins Street | 550 W | | | | .68 | .17 | .27 | .17 | .38 | .83 | .31 | .06 | .22 | .34 |
| 63083 | 122 Brompton Road | 1300 WNW | | | | .13 | .09 | .09 | .13 | .17 | .18 | - | .01 | .08 | .11 |

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